Chapter 1

Fundamentals

1.1 What is Sound Reinforcement?

Have you ever been to a presentation or meeting where you were so far from the presenter that you could only hear and make out every few words or so? “The … and … men … fire.” Very frustrating, and you are left guessing what the speaker is saying most of the time. This is a good example of where sound reinforcement could be used to solve this very basic problem. Sound reinforcement is the process of manipulating and amplifying sound for the purpose of allowing a small source to be heard and understood in and over an area that the source, by itself, would be incapable of covering adequately. Every sound reinforcement system is made up of many individual components, connected together, so that working as a whole they can accomplish the purpose of sound reinforcement.

A live sound reinforcement system is used primarily to amplify sound in a live environment, i.e. one where a large percentage of the sound source is not prerecorded and the environment itself is subject to changes during the process of sound reinforcement. The sound system must be able to do its job and overcome the problems of this environment. To be useful, all live sound reinforcement systems must satisfy at least the following primary requirements:

- Intelligibility
  - Can the audience hear and understand? If the audience cannot understand what is being reproduced, then the system is basically useless.
- Fidelity
  - Does it faithfully reproduce sound from input to output?
- Power
  - Is the level of output sound high enough to cover the intended audience? If there is too little power, intelligibility in the distance will suffer as ambient noise overcomes the source material.
- Monitoring and Controllability
  - Can the operator adequately listen to and adjust what the system is doing? A live sound system accomplishes much of its intelligibility requirements by being highly controllable. This means ability to perhaps move speakers around, move microphones to the proper position to sample the sound, adjust levels of all sources independently, and apply equalization selectively.

If the live sound system is intended to be moved from event to event, then other secondary requirements would be portability, longevity, and flexibility. The system must be rugged; and equipment should not be easily damaged during transportation.

1.2 Sound System Model

Models are used to simplify the analysis and presentation of a complex subject. Our sound system model as shown in Figure 1-1 is very basic. We start with such a basic model because it allows us to focus on the essentials that are required to understand how we create and interact with our sound system. The model shows us that we have five blocks. Devices that capture the sound and get it into a form that the system can process are called input transducers. Once we have the sound in the system, we use signal processors to manipulate the signals that represent the sound. When we are done transforming these signals to meet our needs, we use devices called output transducers to turn those signals back into actual sound again. We refer to these three blocks as the core blocks of the system. The arrows connecting the core blocks show the flow of sound signals. This process all happens in the environment in which these conversions take place, i.e. the space in which the system operates, and so we must somehow take that into account. To complicate matters further, we need to factor in how we as humans perceive the sound (the psychoacoustic interface), because we do not always fully hear what the sound waves are actually carrying. We notice that this model has three parts that are fully under our control (the core blocks) and two parts that are not. Nonetheless, any sound system that we actually put together will follow this model and should attempt to account for all the parts. All of the sound reinforcement issues we talk about in this book will basically be in the context of this model.

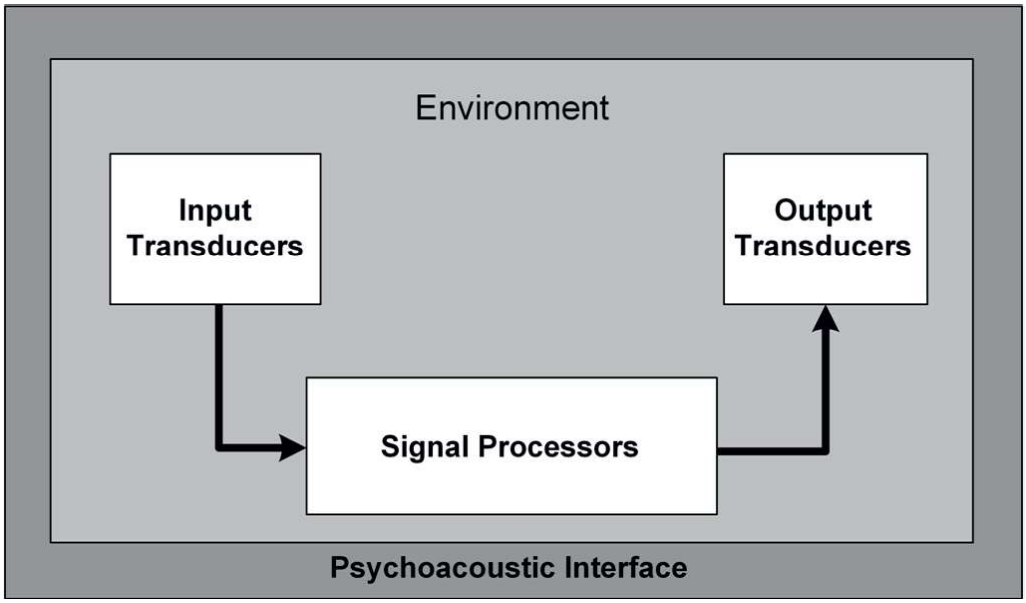

Figure 1-1 Basic Sound System Model

For example, consider Figure 1-2 which shows a high level schematic of the core blocks of a sound system. It basically fleshes out these three parts of the model and shows the type of equipment that may be involved in each block. Input transducers usually consist of microphones. Microphones convert sound energy to electrical energy. This is done so that we can process the sound more effectively. Output transducers are loudspeakers. Loudspeakers convert electrical energy into sound energy after it has been manipulated by the signal processors. The major processors in a live sound system are the mixer, front of house (FOH)[a] amplifier, and the stage monitor amplifier. Other processors consist of effects that help us shape the sound – equalizers,

[a] The term front of house (FOH) refers to equipment or resources whose primary function is to provide audio coverage to the main audience area.

reverb, compressors, and others. Again, the arrows in the figure show us the direction of signal flow and represent electrical cables in the real world. As Figure 1-2 only deals with the core blocks of the system, the environment is not represented there. We will deal extensively with the environment in Chapter 2, and we will highlight important psychoacoustic issues as we encounter them as we proceed through the book.

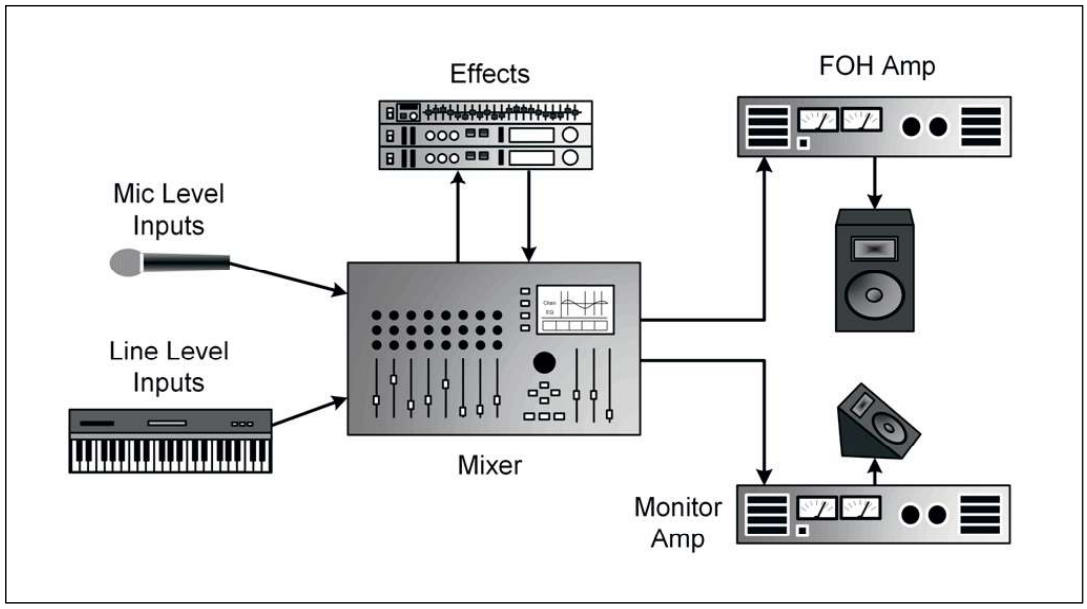

Figure 1-2 Basic Sound System Schematic

Practically all basic sound reinforcement systems use a layout similar to that shown in Figure 1-2. We can summarize this layout and signal flow as follows:

- Inputs (microphones, keyboards, etc.) feed into the mixer.
- The mixer sends and receives signals to and from effects processors.
- The mixer sends signals to the front of house amplifiers.
- The mixer sends signals to the stage monitor amplifiers.
- The amplifiers send signals to the loudspeakers.

~~1.3 What is Sound?~~

When we think of sound, we think of something we can hear. We hear because vibrating air particles impinging on our eardrums transfer energy from the air to our eardrums, causing it to move. This motion is transformed further into electrical impulses that our brain can understand and interpret as sound. Sound is also produced by vibration of matter other than air. For example, sound can be heard when under water, and sound travels through solid objects. However, in this book, we will restrict ourselves to considering vibrations in air.

While air particles always exhibit small random vibrations, they ~~just~~ don't start vibrating wildly in sync on their own. Something typically disturbs the air and causes its particles in turn to vibrate. For example, when a drum is struck and its skin vibrates, it disturbs the air in contact with it. This disturbance travels through the air for long distances. Note that the air itself is not traveling for long distances (that would be wind), but rather the disturbance is traveling through